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PART II

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

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DESIGN STANDARDS FOR HIGHWAYS

Resurfacing, Restoration, and Rehabilitation Projects

[4910-22]

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

[23 CFR Part 625]

[FHWA Docket No. 78-10]

DESIGN STANDARDS FOR HIGHWAYS

Notice of Proposed Rulemaking

AGENCY: Federal Highway Administration, DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: The Federal Highway Administration (FHWA) proposes to amend the existing regulations relating to design standards for highways by adding geometric design standards for resurfacing, restoration, and rehabilitation (RRR) projects. The FHWA has developed a draft entitled "Geometric Design Standards for Resurfacing, Restoration, and Rehabilitation of Streets and Highways Other Than Freeways," FHWA, 1978, as the standard for Federal-aid nonfreeway resurfacing, restoration, and rehabilitation projects. Comments on the specific elements of the criteria and their effect on Federal-aid highway programs are requested.

DATES: Comments on the proposed standards must be submitted by October 23, 1978.

ADDRESSES: Written comments should be sent (preferably in triplicate) to: FHWA Docket No. 78-10, room 4205, 400 Seventh Street SW., Washington, D.C. 20590. All comments received will be available for examination at the above address between 7:45 a.m. and 4:15 p.m. e.t., Monday through Friday.

FOR FURTHER INFORMATION CONTACT:

Seppo I. Sillan, Highway Design Division, Office of Engineering, 202-426-0321, or Lee J. Burstyn, Office of the Chief Counsel, 202-426-0790, Federal Highway Administration, 400 Seventh Street SW., Washington, D.C. 20590.

SUPPLEMENTARY INFORMATION: The FHWA proposes to amend the existing regulation, 23 CFR part 625, Design Standards for Highways, by adding geometric design standards for resurfacing, restoration, and rehabilitation (RRR) projects. RRR is work that is undertaken primarily to preserve an existing facility. Restoration and rehabilitation are considered to be work required to return the existing pavement or bridge deck (including shoulders) to a condition of adequate structural support or to a condition adequate for placement of an additional stage of construction (bridge deck protective system or resurfacing). Resurfacing consists of the placement of additional surface material over the existing, restored, or rehabilitated roadway or bridge deck to improve serviceability or to provide additional strength. RRR work may or may not include changes to geometric features such as minor widening, flattening curves, or improving sight distances.

The proposed standards will not be applicable to freeway projects, which includes the National System of Interstate Highways, nor are they to be used for the construction of a new highway or for reconstruction of an existing one on any system. The provisions, now contained in 23 CFR Part 625, Design Standards for Highways, apply to the above cases. Also, it should be noted that the proposal is not for standards in the strictest sense of the word, but are guides for making realistic decisions as to what criteria should be used. They are intended to provide the lower limit for applying engineering judgment in designing RRR projects and should not be used automatically, but only when higher values are not possible or practical.

Resurfacing, restoration, and rehabilitation work is not new or unique. The States have been doing such work for many years, mostly with non-Federal-aid financing, and under a variety of program titles, although some federally funded RRR projects have also been approved in the past under the existing provisions for design exceptions on an individual project basis. Therefore, the only relatively new aspect is the expanded Federal involvement in the program.

The resurfacing, restoration, and rehabilitation of our highways is vital in order to protect the vast investment which they represent—$76 billion since 1956 in Federal funds alone.[1]

The maintenance of the Federal-aid system, which is 929,000 miles of the Nation's total 3.8 million miles, is the responsibility of the States. that responsibility has been taking an ever increasing share of the States' revenues available for highways. At the same time due to inflationary pressures, the actual real value of such revenues has depreciated. In general the quality of pavement has declined nationally. Pavements that are allowed to deteriorate will: (1) increase vehicle operating cost, (2) increase fuel consumption, (3) adversely affect safety due to reduced skid resistance and roughness, and (4) adversely affect the driving comfort. Therefore, it is apparent that there is a need for RRR work to improve the service and extend the life of more miles of high way through optimized geometri design standards that reflect a regar for preservation without sacrificin traffic safety.

The Congress recognized that nee by amending section 101 of title 23 United States Code, by including ir the definition of the term "construc tion" the words "resurfacing, restora tion, and rehabilitation." The purpos of the amendment is to provide great er flexibility in the use of Federal funds for obtaining maximum use from the extensive system of existing facilities by improving their service ability through measures short of complete reconstruction. That purpose is expressed in several congressional committee reports.[2]

The General Accounting Office report on maintenance recommended that FHWA should encourage States to give a high priority to RRR projects in their Federal-aid highway construction programs.

Also, one of the findings of a recent National Highway Inventory and Performance Study, as reported in the Secretary of Transportation's report to Congress[3] on the status of highways, was:

> In order to avert deterioration in the quality of pavements and bridges, and to maintain a satisfactory level of operating performance, commitments by Federal, State, and local governments to highway preservation are necessary. Postponing rehabilitation can only increase the long-run costs of maintaining good performance due to the progressive nature of deterioration and the predicted growth in price inflation.

The fact that the 1976 Highway Act amended the definition of the term "construction" to allow greater latitude in designing and constructing certain specific types of projects did not mean that other parts of the law were repealed or could be ignored, especially those on safety. Neither does the law require that any one facet must overwhelmingly govern above all others. They must all be woven together in a manner that will adequately meet the existing and probable future traffic needs, conditions, and particular needs of each locality.

An advance notice of proposed rulemaking (ANPRM) for establishing geometric design standards for RRR projects was published in the FEDERAL REGISTER at 42 FR 42876 (August 25, 1977) on FHWA docket No. 77-4. The

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[1] "Improving and Maintaining Federal-Aid Roads—Department of Transportation Action Needed," U.S. General Accounting Office, February 2, 1977.

[2] (a) H.R. Rept. No. 1567, 93d Cong., 2d sess. 3 (1974); (b) H.R. Rept. No. 109, 94th Cong., 1st sess. 5 (1975); (c) S. Rept. No. 485, 94th Cong., 1st sess. 7, 8 (1975); (d) H.R. Rept. No. 716, 94th Cong., 1st sess. 5, 6 (1975); (e) H.R. Rept. No. 1017, 94th Cong., 2d sess. 42, 43 (1976).

[3] "The Status of the Nation's Highways: Conditions and Performance. Report of the Secretary of Transportation to the U.S. Congress," September 1977.

original due date for comments was extended to November 22, 1977, by a notice published in the FEDERAL REGISTER at 42 FR 56751 (October 28, 1977). All suggestions and proposals for establishing RRR standards were requested. Additionally, three specific alternatives were offered for consideration. Two of the proposed alternatives involved the "Geometric Design Guide for Resurfacing, Restoration, and Rehabilitation (RRR) of Highways and Streets," American Association of State Highway and Transportation Officials (AASHTO), 1977.

After reviewing the comments that were made on the proposal, as well as the legislative background and physical needs of the highway system, it was concluded that:

1. Because of some of the severe comments on the specific criteria contained therein, the FHWA decided not to adopt the AASHTO "Geometric Design Guide for Resurfacing, Restoration, and Rehabilitation (RRR) of Highways and Streets," 1977, in its present form for Federal-aid projects.

2. Using comments received in response to the ANPRM and other available information, FHWA will develop geometric design criteria for Federal-aid RRR projects.

3. Until such time as separate FHWA criteria are promulgated, RRR projects will be handled under the current procedures contained in extisting 23 CFR part 625. These existing procedures permit the needed flexibility in the geometric design of RRR projects through approval of exceptions on a project-by-project basis. Although not considered an adequate long-term solution, this interim procedure can be used immediately to provide the latitude needed for implementing Federal-aid RRR projects.

4. Emphasis will be given to the evaluation of the RRR program.

This information was part of the notice of withdrawal of the advance notice of proposed rulemaking published in the FEDERAL REGISTER at 43 FR 2734 (January 19, 1978).

The criteria now being proposed for adoption are contained in the draft of "Geometric Design Standards for Resurfacing, Restoration, and Rehabilitation of Streets and Highways Other Than Freeways." The text of this document is in this notice. The FHWA has developed this guide using comments received in response to the ANPRM, and other available information such as any research on the subject, or on subjects closely related to RRR, as well as all existing policies and guides on the geometric design of highways.

The provisions of Title 23 of the United States Code provide for a federally assisted State program. In furtherance of the objectives of this program and in accordance with the general purposes of Title VI of the Intergovernmental Cooperation Act of 1968, Pub. L. No. 90-577, 82 Stat. 1098, the development of the RRR standards will be carried out in full coordination with the States. Copies of the proposed standards are being provided directly to the States and to interested associations.

The FHWA would prefer to see one set of standards apply to all RRR work nationwide rather than separate standards dependent solely on the type of funding available. Accordingly, following analysis of all comments received as a result of this notice and appropriate revision of the proposed standards, FHWA will request adoption of the standards by the States as a standard of the American Association of State Highway and Transportation Officials.

It is well known that in aggregate, the higher (within reason) the criteria for most design elements are, the safer the facility will be. That has been shown by the experience with the Interstate System of Highways which is built to the highest standards. For obvious reasons, all roads cannot be built to the same high standards. A farm to market road with full control of access is totally unrealistic. The design, therefore, must vary with the intended function of the facility.

Because the existing research does not provide reliable information on the full impact of variances in individual design criteria, considerable judgment and opinion based on past experience and knowledge have to be used to supplement the current data in developing proper standards for RRR, i.e., preservation projects. Many remaining questions will be answered and problems resolved by future research, development, and evaluations. Meanwhile, to avoid the deterioration of the existing highway system beyond reasonable usefulness, immediate steps must be taken to preserve it.

Many of those who responded to the ANPRM supported the adoption of the AASHTO RRR Guide for use on Federal-aid work. Many others had serious doubts about it, some perhaps caused by a misunderstanding about the character of RRR work, the need for it, the application and the intent of the guide, and its philosophy, as well as its specific numerical values. A brief discussion of the major concerns and how they have been accounted for in the standards proposed for adoption by this notice follows.

One of the basic concerns was that the guide would have reduced standards for all highway construction. The current proposal makes it clear that the proposed standards are intended only for nonfreeway RRR projects, and existing standards will continue to apply to all new construction, reconstruction, and all freeway work.

Criticism was also directed at the apparent lack of emphasis on safety. The current proposal provides for safety throughout by encouraging the use of the highest practical design criteria, by requiring certain safety improvements such as on bridge approaches, and by requiring an analysis of the project's accident history to determine hazardous locations to be improved. Therefore, by improving safety to a reasonable extent, by improving the service, and by extending the life of more miles of highway through optimized geometric design standards, substantial systemwide safety benefits can be realized.

The section on lane and shoulder widths has been modified to take into account the effects of various traffic conditions such as volume, and percentage of trucks and buses, and whether urban or rural conditions prevail.

The section on bridges has been rewritten to clearly designate under what conditions structures that do not meet the current non-RRR criteria may be retained without reconstruction on RRR projects. Because about 73 percent of errant vehicles at bridges impacted either the approach railing or bridge ends, the proposed standards require that the approach barriers must always be upgraded to meet current criteria.

The superelevation criteria now applicable to new projects is also the basis for superelevation on RRR projects. This eliminates the concerns expressed over the possibilities of extensive reversed "banking" of curves under the criteria proposed in the Advance Notice of Proposed Rulemaking.

It should be noted that because of the specific type of projects for which these standards are intended, the limits are broader and minimums somewhat lower than those for new construction or reconstruction. Therefore, a RRR project, on an individual project basis, may not necessarily achieve the same degree of traffic service and safety as a project designed to existing standards. However, in total, greater systemwide safety can be achieved by being able to improve more miles of highways.

This proposed amendment of 23 CFR Part 625 is not considered to produce a major effect on the general economy in terms of costs, consumer prices, or production, nor will it produce a major increase in costs or prices for individual industries, level of government, geographic regions, or specific elements of the population. No new reporting requirements, other than identifying by code RRR projects on existing programing documents, are

imposed on any level of government, industry, or the public in general.

Determination of the systemwide impacts of the RRR program and the specific criteria in the proposed standards will be accomplished through individual evaluations and research studies. Also, RRR activities will be monitored through the existing project and program review procedures of FHWA.

Draft evaluation of the proposed regulation is on file and available for examination at the address given at the beginning of this notice.

The entire regulation, 23 CFR Part 625, to which this amendment is proposed was published in the FEDERAL REGISTER at 43 FR 14648 (April 7, 1978).

NOTE.—The FHWA has determined that this document does contain a major proposal according to the criteria established by the Department of Transportation pursuant to E.O. 12044.

In consideration of the foregoing, it is proposed to amend 23 CFR Part 625.3(a) by renumbering existing paragraphs (6) through (20) to read (7) through (21) and adding a new paragraph (6) to read as follows:

Section 625.3(a)(6) Geometric Design Standards for Resurfacing, Restoration, and Rehabilitation of Streets and Highways Other Than Freeways, FHWA, 1978. These standards represent the minimum criteria to which nonfreeway RRR projects may be designed.

The text of the "Geometric Design Standards for Resurfacing, Restoration, and Rehabilitation of Streets and Highways Other Than Freeways," FHWA, 1978 proposed to be incorporated by reference in the regulation, is as follows:

GEOMETRIC DESIGN STANDARDS FOR RESURFACING, RESTORATION, AND REHABILITATION (RRR) OF STREETS AND HIGHWAYS OTHER THAN FREEWAYS

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DEFINITIONS

Resurfacing, Restoration and Rehabilitation (RRR)—Work undertaken primarily to preserve an existing facility. Restoration and Rehabilitation is considered to be work required to return the existing pavement or bridge deck (including shoulders) to a condition of adequate structural support or to a condition adequate for placement of an additional stage of construction (bridge deck protective system or resurfacing). Resurfacing consists of the placement of additional surface material over the existing, restored, or rehabilitated roadway or bridge deck to improve serviceability or to provide additional strength. RRR work may or may not include changes to geometric features, such as minor widening, flattening curves, or improving distances.

New Construction and Reconstruction—Building a facility where none existed previously, or the replacement of an existing facility.

Existing Standards—Those current documents [1] that contain criteria and discussions to be used as the basic model or pattern of guidance in developing the geometric design of highways and streets.

INTRODUCTION

The 1976 Federal-aid Highway Act made it possible for the State and local highway agencies to use Federal funds to improve the service and extend the life of the maximum possible miles of the total highway system.

One of the findings of a recent National Highway Inventory and Performance Study (NHIPS)[2] was:

In order to avert deterioration in the quality of pavements and bridges, and to maintain a satisfactory level of operating performance, commitments by Federal, State, and local governments to highway preservation are necessary. Postponing rehabilitation can only increase the long run cost of maintaining good performance due to the progressive nature of deterioration and the predicted growth in price inflation.

Highways for which geometrics were established some years ago are still capable of performing a useful transportation service. In most cases minor improvements will make such highways serviceable for many more years.

Recognizing that highway resources are limited, a flexible approach to design which is consistent with environmental and community values is essential to meet the pressing need for preserving the functional and safety characteristics of the existing highway systems. The geometric design standards that are appropriate for new construction and reconstruction are not the optimum criteria for resurfacing, restoration, and rehabilitation (RRR) projects. It is important that designers have guidelines for making realistic decisions as to what criteria should apply. Therefore, to assure the future usefulness of the highway system and to assure that all factors, especially safety, are considered adequately and uniformly nationwide, RRR geometric design standards separate from existing standards for new construction and reconstruction are needed.

The geometric standards in this document are the minimums considered acceptable and are intended to provide the lower limit for applying engineering judgment in designing nonfreeway RRR projects. As with the design of any type of project, the minimums should not be applied automatically but used only when higher values are not possible or practical. The criteria used should be compatible with the proposed improvement. For example, higher geometric criteria should be applied to a project for a 6-inch pavement overlay than for a ¾-inch overlay.

RRR projects designed to the standards in this document will enable the improvement of safety and traffic service on a large portion of the highway system without requiring total reconstruction. Because of the specific type of projects for which these standards are intended, the limits are broader and minimums somewhat lower than the existing standards for new construction or reconstruction. A RRR project, on an individual project basis, may not necessarily achieve the same degree of traffic service and safety as a project designed to existing standards. However, in total, greater systemwide traffic service and safety can be achieved by being able to improve more miles of highways.

These standards are intended to provide flexibility in some of the basic geometric design features, especially those on which modification could result in appreciable savings in cost and other impacts and still improve the degree of safety and traffic service.

For any of the other numerous design details not covered here, the existing standards for new construction or reconstruction will govern. Most of such criteria are already sufficiently flexible and further flexibility would not result in appreciable cost savings and may even result in reduced performance.

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[1] "A Policy on Geometric Design of Rural Highways," AASHO 1965; "A Policy on Design of Urban Highways and Arterial Streets," AASHO 1973; "Geometric Design Standards for Highways other than Freeways," AASHO 1969; "Geometric Design Guide for Local Roads and Streets," AASHO 1970. (See App. B for the availability of these and other documents referenced in this publication.)

[2] "The Status of the Nation's Highways: Conditions and Performance. Report of the Secretary of Transportation to the United States Congress," September 1977.

This document is intended to modify some of the requirements for geometric design features of nonfreeway RRR projects only. All other project procedures are applicable and should be modified only according to existing administrative policies.

These standards are applicable to all rural nonfreeway RRR projects. Because of physical constraints and operational characteristics of many urban streets, the only urban facilities these criteria apply to are the nonfreeway arterials. This document does not provide minimum criteria for urban local and collector streets. The standards for these facilities are those criteria acceptable to the local jurisdiction.

GEOMETRIC STANDARDS

TRAFFIC DATA

Traffic data required to be collected and anaylzed for RRR projects is that which will allow the determination of the necessary level of improvement (i.e., RRR or reconstruction), establishment of necessary design elements such as pavement and bridge widths, and proper consideration for safety.

As a minimum the following data should be acquired and analyzed for all RRR projects:

Current mainline ADT and DHV. (Average Daily Traffic and Design Hourly Volume).

Percent of trucks and buses.

Accident locations and descriptions (collision diagrams).

Turning movements and pedestrian volumes at signalized and problem intersections and at major traffic generators.

Any known near future traffic impact.

School and other bus usage of the route or project.

DESIGN SPEED

The purpose of a design speed is to correlate those physical features of a highway that influence vehicle operation. It is also the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features govern. For new construction and reconstruction the assumed design speed should be logical with respect to the character of terrain and the type of highway, and it should be as high as practical.

Although the selection of design speed for a RRR project through a process or rationale which is the same as for new construction is the most desirable approach, it may not be the most practical in view of the character of RRR projects. Application of an ideal design speed that has no relationship to the speeds actually found on an existing highway would be arbitrary. Some operational value that reflects the existing conditions (driver, vehicle, roadway, environmental, and traffic constraints) would be more appropriate. The one value that is readily obtainable and which most closely reflects the existing conditions is the average running speed. "Running Speed" is defined as the speed of a vehicle over a specified section of highway, being the distance divided by the running time; i.e., the time the vehicle is in motion.

Average running speed varies during the day depending primarily on the volume of traffic. It is important that the running speed be determined for the appropriate traffic conditions if it is to be the basis for selecting the design speed. The speed to be measured should be for the freeflowing or low volume conditions.

Since the average running speed represents speed applicable to only about half the motorists on a section of highway, some modification of this value is needed. A 10-percent increase in the average running speed rounded up to the nearest 5 mph (8km/h) increment should be used.

It is also important when considering a RRR project for a section of highway to consider the geometric conditions beyond the portion to be improved. Every attempt should be made to maintain a uniform speed for a significant segment of highway.

Urban arterial streets and highways with some access control and fairly long distances between intersections should have a design speed determined according to the above procedures. However, arterials that have obvious "street-like" characteristics, operationally and physically, do not require a design speed determination. Typically in such instances, closely spaced intersections and other operational constraints usually limit vehicular speeds making the effect of design speed of no significance in the design.

In order to obtain an equivalent average running speed on an existing facility spot speed measurements may be used. The "average spot speed" is the arithmetic mean speed of all traffic at a specified point. Such an average spot speed may be considered to be representative of the average running speed on short sections of highway with essentially uniform characteristics. On longer stretches of highway, spot speeds measured at several points may be averaged (taking relative lengths into account) to represent the average running speed.

It is not intended that elaborate studies be conducted for RRR projects. A few simple representative measurements will be adequate.

SUPERELEVATION

Superelevation is one of the critical speed-related aspects of design that is relatively easy to correct on most RRR projects. The variables involved are the rate of roadway superelevation, side friction factor, vehicle speed and radius of curvature. The laws of mechanics form the basis and those values are modified by practical limitation and factors to provide logical design controls.

In order to provide for the same degree of safety and comfort as on any other project, superelevation including transitions, in accordance with the standards for new construction or for reconstruction should be provided on rural resurfacing, restoration, and rehabilitation projects (See Tables 1-5 in app. A) When constraints make such values infeasible or impractical for the design speed, highest reasonably achievable values may be used.

in rurual areas conditions that would require deviation from the normal superelevation practices should be quite infrequent. The feasibility of rebuilding horizontal curves to larger radii and appropriate superelevation must always be considered, especially when accident data indicate that a problem exists. Urban arterial streets and highways should, within the constraints imposed by adjacent development, curbs and sidewalks, be superelevated in accordance with the same criteria as for rural highways.

When the superelevation applied to a curve does not meet the appropriate criteria, the maximum safe speed for that curve must be determined and the curve signed and marked in accordance with the provisions of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).

An accepted engineering practice for determining the safe speed is the use of ball bank indicator (BBI). The BBI reading at any time is indicative of the combined effect of the vehicle body roll, the centrifugal force, and the superelevation. A 10° BBI reading is indicative of a safe speed on a curve at the practical speed range of 35 to 60 mph (56 to 97km/h).

If a BBI is not available, Figure 1 of Appendix A which relates the maximum degree of curve to the rate of superelevation and speed, may be used. When entered with a given degree of curve or radius and a known rate of superelevation, the speed that very closely corresponds with 10° BBI reading can be readily determined.

Normal pavement cross slopes may vary from 1 to 3 percent. Existing slopes that are too flat or too steep should be altered to within that range, with the perferred cross slope being 2 percent.

ROADWAY AND SURFACING WIDTHS

The acceptable minimum roadway and surfacing widths for two-lane. two-way rural RRR projects are given in Table I.

TABLE I.—*Roadway and surfacing widths*

Current traffic (ADT)	Design speed (mph)	Width (ft)			
		10 percent or more trucks		Less than 10 percent trucks	
		Roadway	Surfacing	Roadway	Surfacing
1-400	All	24	20	24*	20*
401-4000	50 or less	26	22	24	20
	Over 50	30	24	28	22
Over 4000	All	32	24	30	22

(Conversion factors: 1 mph = 1.609km/h, 1 ft = 0.305m.)

* Note.—For design speeds of 50 mph (80km/h) or less, widths 2 feet (0.6m) narrow may be used on minor roads.

For multilane rural highways, the lanes should be 11 feet (3.4m) wide and the shoulder widths should be 4 feet (1.2m) on the right and 2 (0.6m) feet on the left. If the design speed is 50 mph (80km/h) or less and the percentage of trucks is less than 10 percent, 10 foot (3.1m) lanes may be used.

For urban conditions constraints are such that roadway widening is frequently not practical or possible. The following are minimum lane widths and curb offsets for urban arterial RRR projects:

Through and turning lanes: 10 ft (3.1m).
Parking lanes: 8 ft (2.4m).
Curb Offset—Design Speed 40 mph (64km/h) or less: None. Design speed over 40 mph (64km/h) 1 ft (0.3m).

NOTES.—(1) Lane widths of 9 ft (2.7m) may be used on one-way steets or divided roadways if at least a 1-ft (0.3M) curb offset is used or if trucks and buses are prohibited. (2) If an uncurbed, open ditch, cross section design is used where urban conditions are present, it should be in accordance with the rural criteria.

CURVATURE, STOPPING SIGHT DISTANCE, AND GRADES

The horizontal and vertical curvature, and the stopping sight distance are criteria which are directly related to the speed of vehicles, and major deviations from the proper design may cause serious problems. These geometric characteristics can be the most difficult and costly to improve and although every horizontal or vertical sight restriction can create a potential hazard, improvement on that basis alone may not be practical on every RRR project.

If the curvature is shown to be the cause of the accidents, some corrective action must be taken. This corrective action can range from reconstruction to the placement of warning signs and markings.

Alignment improvements should be undertaken when the accident experience is high and if previously installed warning signs, markings or other devices have not proven to be effective. In many cases, under both rural and urban conditions existing horizontal or vertical alignment may be retained if a careful analysis indicates that it can be adequately signed and marked.

If the calculated design speed for a particular horizontal or vertical curve is less than 15 mph (24km/h) below the designated design speed of the adjacent sections and the location is not an identified accident location, proper signs and markings may be used to inform the drivers of the condition in lieu of reconstruction to meet the standards for the assumed design speed. When the difference is 15 mph (24km/h) or more or the design speed of the horizontal or vertical curve is less than 20 mph (32km/h) corrective work must be considered and should be undertaken unless the cost or other factors would make the improvement impractical. If improvement is not possible, additional signs and markings and other provisions must be used to provide for proper speed transition.

Sight distance at horizontal curves can often be improved, short of reconstruction, by minor cut slope flattening or selective clearing or both. If such work cannot be done, the actual sight distance must be measured, the maximum safe speed determined, and the location signed and marked accordingly.

Safe speed for vertical curves with stopping sight distance restrictions must also be determined. A warning sign with the legend "Limited Sight Distance" is available for use in such situations.

Grades generally do not need to be flattened on RRR projects. Steep grades and restricted horizontal or vertical curvature in combination, however, may warrant corrective action. In summary, the retention of existing grades, curvature or stopping distances which do not meet the existing minimum criteria must be based on good judgment founded on a critical analysis of the conditions. Sites that have a known accident experience related to these geometric features must be corrected, preferably by reconstruction. If that is not possible, signs, markings and other devices, above and beyond the normal requirements, must be installed. If such measures have not worked adequately in the past at a particular location, then reconstruction is required.

BRIDGES

For bridges located of RRR projects, decisions must be made on their retention or replacement, including special consideration for structures with historical significance. If replacement is required, the bridges should be designed in accordance with the current AASHTO geometric and structural standards for new bridges and be consistent with the standards to which the highway may be upgraded in the foreseeable future.

For bridges to remain in place, an evaluation must be made to determine what treatment, if any, is required for operational and structural adequacy. National Cooperative Research Highway Program (NCHRP) Research Results Digest 98, Safety at Narrow Bridge Sites, provides guidance for making the operational safety evaluation. Categories of bridges to remain in place are (1) Bridges requiring no work or only minor rehabilitation, and (2) Bridges requiring major rehabilitation.

1. *Bridges requiring no work or only minor rehabilitation:* When an existing highway or street is to be resurfaced, restored or rehabilitated, existing highway bridges 18 feet wide or wider may remain in place provided:

a. The bridge clear roadway width is equal to or greater than the values for minimum surfacing or traveled way widths provided by these criteria, or if the bridge clear roadway width is less than that minimum surfacing width or traveled way, accident experience indicates that no accident problem exists and the approach way is gradually narrowed to meet the bridge clear roadway width in advance of the bridge. (When an accident problem exists, an analysis should be made to determine the necessary corrective action such as providing improved transitions, rehabilitation, or replacement.)

b. To the extent practical, the bridge railings meet or are made to meet adequate strength and geometric standards.

c. The load carrying capacity is sufficient to carry school buses and vital service vehicles (H-15 minimum) where there is no reasonable and adequate alternative route.

2. *Bridges requiring major rehabilitation:* The design of high cost deck replacement and/or major rehabilitation shall, to the extent practical, be in accordance with the current AASHTO Standard Specifications for Highway Bridges for the class of highway of which the structure is an integral part (H-15 minimum design loading) and meet current AASHTO geometric and safety standards for bridges. When it is not practical to widen to existing geometric standards due to such factors as physical constraints and/or operational characteristics, Table II values apply.

All bridges within the RRR project limits shall be signed and marked in accordance with the MUTCD and the criteria as specified in the AASHTO report, "Highway Design and Operational Practices Related to Highway Safety, Second Edition, 1974." Approach traffic barriers are to be in conformance with the "Guide for Selecting, Locating, and Designing Traffic Barriers, AASHTO, 1977."

TABLE II.—*Bridge Widths For Bridges Requiring Major Rehabilitation*

Current (ADT)	Traffic DHV	Clear Roadway Width* (ft) Desirable minimum	Minimum
0-50		24	20
51-250		26	20
251-400		28	22
401-750	100-200	28	22
	201-400	32	24
	Over 400	36	28

Metric Conversion: 1 ft = 0.305m.

* NOTE.—Clear Width between curbs or rails whichever is the lesser.

HORIZONTAL CLEARANCE TO OBSTRUCTIONS

For safety, it is desirable to provide a clear roadside recovery area that is as wide as practical, but because of existing topographic features and right-of-way limitations associated with RRR work, considerable judgment must be used. The clear zone must be given particular attention at identified roadside accident locations (fixed object accidents). Good engineering judgment, cost effectiveness, and consideration of community impact may also influence decisions.

Widening to provide more clear distance through short sections of rock cuts should be considered. In longer rock cuts, protrusions should be cut back or protected, if warranted. An adequate clear zone at some horizontal curves, especially those at the end of a downgrade, should be provided if possible. A review of accident data will help to define dangerous obstructions.

Under urban conditions the minimum setback for an obstruction should be behind the paved shoulder or 2 feet (0.6m) behind the curb. Where sidewalks are to be included, it is desirable to locate all obstructions behind them.

SAFETY APPURTENANCES

Safety appurtenances for reducing the severity of run-off-the-road accidents include longitudinal roadside barriers (including bridge rails), crash cushions, breakaway or yielding sign supports, and breakaway luminaire supports. It is desirable that such installations be upgraded to meet the current criteria for strength, structural details, location, and warants. The upgrading should be accomplished through a systematic program based on priorities by requiring low priority improvements to be a part of the RRR project. However, a RRR project can and should influence those priorities to a reasonable degree. The inclusion of priority safety upgrading work with a RRR project can be beneficial to both programs. For instance, the engineering and other project costs of separate projects may be reduced. For information in this area refer to the 1977 "Guide for Selecting, Locating, and Designing Traffic Barriers," and the 1975 "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals" by AASHTO.

OTHER

As noted in the introduction, there are numerous other design features, details, and components in planning and designing a RRR project which may or may not be appropriate. However, if some such items are included in the RRR project, they should be designed according to existing guidelines and criteria.

In some cases there are no alternatives to the inclusion of certain design features. The law imposes certain requirements. For instance, all Federal-aid projects that provide curbs shall include curb ramps at all pedestrian crosswalks, and other provisions as may be appropriate for physically handicapped persons. Also, all projects shall be signed and marked according to the MUTCD.

Other features such as landscaping, bikeways, rest areas or scenic overlooks are optional. A RRR project can be a good opportunity or a vehicle for implementation of an already identified need, such as a bikeway. The decision to include these types of work depends greatly on the local conditions, attitudes and needs and is left up to the individual highway designers and administrators.

APPENDICES

APPENDIX A—SUPERELEVATION AND MAXIMUM SAFE SPEED ON CURVES

The basic equation that relates to the vehicle operation on a curve is:

$$e+f=V^2/15R$$

where e = rate of roadway superelevation, foot per foot
f = side friction
v = vehicle speed, mph.
h = radius of curve in feet

The design assumptions for the side friction factor (f) are:

v	f
30	.16
40	.15
50	.14
60	.13
70	.12

Briefly, for a given curve to be safe according to the accepted design assumptions at a given speed, the sum of the actual superelevation rate and the corresponding assumed friction factor value must be equal to or exceed the value which can be determined by the basic equation above. More detailed discussions of the basic philosophy and assumptions for recommended superelevation design practice are contained in "A Policy on Geometric Design of Rural Highways," AASHO, 1965. Table 1 thru 5 give the design superelevation values based on maximum rates of 0.04, 0.06, 0.08, 0.10, and 0.12.

Figure 1 is intended as an operational design aid in lieu of a ball bank indicator. The safe speed can be determined simply by projecting horizontally from a known "e" value and vertically from the radius of curve. The intersection of these lines indicates the maximum safe speed.

The family of curves in Figure 1 is developed on the basis of the same basic rationale and assumptions as stated above and contained in the noted reference. The curves are the result of solving the basic equation for given conditions.

The curves represent the maximum degrees of curvature (or minimum radius) for various values of superelevation rate and vehicle speed. (These are the same values of curvature as contained in the boxes highlighted by heavy lines in Tables 1-5). It is emphasized that the curves represent maximum safe degrees of curve only and do not distribute an assumed maximum rate of superelevation throughout the range of intermediate degrees of curvature as do the Table (1 thru 5) for design values.

TABLE I

VALUES FOR DESIGN ELEMENTS
RELATED TO DESIGN SPEED AND HORIZONTAL CURVATURE

D	R	V = 30			V = 40			V = 50			V = 60		
			L			L			L			L	
		e	2-lane	4-lane	e	2-lane	4-lane	e	2-lane	4-lane	e	2-lane	4-lane
0° 15′	22918′	NC	0	0	NC	0	0	NC	0	0	NC	0	0
0° 30′	11459′	NC	0	0	NC	0	0	NC	0	0	RC	175	265
0° 45′	7639′	NC	0	0	NC	0	0	RC	150	225	.016	175	265
1° 00′	5730′	NC	0	0	RC	125	190	.016	150	225	.020	175	265
1° 30′	3820′	RC	100	150	.015	125	190	.020	150	225	.025	175	265
2° 00′	2865′	RC	100	150	.018	125	190	.023	150	225	.028	175	265
2° 30′	2292′	.015	100	150	.020	125	190	.026	150	225	.032	175	265
3° 00′	1910′	.016	100	150	.022	125	190	.028	150	225	.035	175	265
3° 30′	1637′	.017	100	150	.024	125	190	.030	150	225	.037	175	265
4° 00′	1432′	.018	100	150	.025	125	190	.033	150	225	.040	175	265
5° 00′	1146′	.021	100	150	.028	125	190	.036	150	225	.040	175	265
6° 00′	955′	.023	100	150	.031	125	190	.040	150	225	D max. = 4.0°		
7° 00′	819′	.024	100	150	.033	125	190	.040	150	225			
8° 00′	716′	.026	100	150	.036	125	190	D max. = 6.0°					
9° 00′	637′	.028	100	150	.038	125	190						
10° 00′	573′	.029	100	150	.040	125	190						
11° 00′	521′	.031	100	150	.040	125	190						
12° 00′	477′	.032	100	150	D max. = 10.0°								
13° 00′	441′	.033	100	150									
14° 00′	409′	.035	100	150									
16° 00′	358′	.037	100	150									
18° 00′	318′	.039	100	150									
		.040	100	150									
		D max. = 19.0°											

$e_{max}=0.04$

D - Degree of curve
R - Radius of curve
V - Assumed design speed
e - Rate of superelevation
L - Minimum length of runoff or spiral curve
NC - Normal crown section
RC - Remove adverse crown, superelevate at normal crown slope
Spirals are desirable but not as essential above heavy line.
Lengths rounded in multiples of 25 or 50 feet permit simpler calculations.

TABLE II

VALUES FOR DESIGN ELEMENTS

RELATED TO DESIGN SPEED AND HORIZONTAL CURVATURE

D	R	V = 30 mph			V = 40			V = 50			V = 60			V = 65			V = 70			V = 75			V = 80 mph		
		e	L-Feet		e	L		e	L		e	L		e	L		e	L		e	L		e	L-Feet	
			2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane
0° 15'	22918'	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	C	0	NC	0	0	NC	0	0	RC	240	240
0° 30'	11459'	NC	0	0	NC	0	0	NC	0	0	RC	175	175	RC	190	190	RC	200	200	.021	220	220	.023	240	240
0° 45'	7639'	NC	0	0	NC	0	0	RC	0	0	.021	175	175	.023	190	190	.026	200	200	.030	220	220	.033	240	240
1° 00'	5730'	NC	0	0	RC	125	125	.020	150	150	.027	175	175	.029	190	190	.033	200	200	.037	220	220	.041	240	240
1° 30'	3820'	RC	100	100	.020	125	125	.028	150	150	.036	175	175	.040	190	190	.044	200	200	.050	220	240	.053	240	260
2° 00'	2865'	RC	100	100	.026	125	125	.035	150	150	.044	175	180	.048	190	210	.052	200	230	.057	220	270	.059	240	290
2° 30'	2292'	.020	100	100	.031	125	125	.040	150	150	.050	175	200	.053	190	230	.057	200	260	.060	220	290	.060	240	300
3° 00'	1910'	.023	100	100	.035	125	125	.044	150	160	.054	175	220	.057	190	250	.060	200	270	.060	220	290	.060	240	300
3° 30'	1637'	.026	100	100	.038	125	125	.048	150	170	.057	175	230	.059	190	250	.060	200	270	D max = 2.5°			D max = 2.5°		
4° 00'	1432'	.029	100	100	.041	125	130	.051	150	180	.059	175	240	.060	190	260	D max = 3.0°								
5° 00'	1146'	.034	100	100	.046	125	140	.056	150	200	.060	175	240	.060	190	260									
6° 00'	955'	.038	100	100	.050	125	160	.059	150	210	D max = 4.5°			D max = 4.0°											
7° 00'	819'	.041	100	110	.054	125	170	.060	150	220															
8° 00'	716'	.043	100	120	.056	125	180	.060	150	220															
9° 00'	637'	.046	100	120	.058	125	180	D max = 7.0°																	
10° 00'	573'	.048	100	130	.059	125	190																		
11° 00'	521'	.050	100	140	.060	130	190																		
12° 00'	477'	.052	100	140	.060	130	190																		
13° 00'	441'	.053	100	140	D max = 11.5°																				
14° 00'	409	.055	100	150																					
16° 00'	358'	.058	100	160																					
18° 00'	318'	.059	110	160																					
20° 00'	286'	.060	110	160																					
		.060	110	160																					
		D max = 21.0°																							

$e_{max} = 0.06$

D -- Degree of curve
R -- Radius of curve
V -- Assumed design speed
e -- Rate of superelevation
L -- Minimum length of runoff of spiral curve
NC -- Normal crown section.
RC -- Remove adverse crown, superelevate at normal crown slope.
Spirals desirable but not as essential above heavy line.
Lengths rounded in multiples of 25 or 50 feet permit simpler calculations.

TABLE III

VALUES FOR DESIGN ELEMENTS

RELATED TO DESIGN SPEED AND HORIZONTAL CURVATURE

D	R	V = 30 mph			V = 40			V = 50			V = 60			V = 65			V = 70			V = 75			V = 80 mph		
		e	L-Feet		e	L		e	L		e	L		e	L		e	L		e	L		e	L	
			2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane
0° 15'	22918'	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	240	240
0° 30'	11459'	NC	0	0	NC	0	0	NC	0	0	RC	175	175	RC	190	190	RC	200	200	.022	220	220	.024	240	240
0° 45'	7639'	NC	0	0	NC	0	0	RC	150	150	.022	175	175	.025	190	190	.029	200	200	.032	220	220	.036	240	240
1° 00'	5730'	NC	0	0	RC	125	125	.021	150	150	.029	175	175	.033	190	190	.038	200	200	.043	220	220	.047	240	240
1° 30'	3820'	RC	100	100	.021	125	125	.030	150	150	.040	175	175	.046	190	200	.053	200	240	.060	220	290	.065	240	320
2° 00'	2865'	RC	100	100	.027	125	125	.038	150	150	.051	175	210	.057	190	250	.065	200	290	.072	230	340	.076	250	380
2° 30'	2292'	.021	100	100	.033	125	125	.046	150	170	.060	175	240	.066	190	290	.073	220	330	.078	250	370	.080	260	400
3° 00'	1910'	.025	100	100	.038	125	125	.053	150	190	.067	180	270	.073	210	320	.078	230	350	.080	250	380	.080	260	400
3° 30'	1637'	.028	100	100	.043	125	140	.058	150	210	.073	200	300	.077	220	330	.080	240	360	.080	250	380	D max = 2.5°		
4° 00'	1432'	.032	100	100	.047	125	150	.063	150	230	.077	210	310	.079	230	340	.080	240	360	D max = 3.0°					
5° 00'	1146'	.038	100	100	.055	125	170	.071	170	260	.080	220	320	.080	230	350	D max = 3.5°								
6° 00'	955'	.043	100	120	.061	130	190	.077	180	280	.080	220	320	D max 4.5°											
7° 00'	819'	.048	100	130	.067	140	210	.079	190	280	D max = 5.0°														
8° 00'	716'	.052	100	140	.071	150	220	.080	190	290															
9° 00'	637'	.056	100	150	.075	160	240	D max 7.5°																	
10° 00'	573'	.059	110	160	.077	160	240																		
11° 00'	521'	.063	110	170	.079	170	250																		
12° 00'	477'	.066	120	180	.080	170	250																		
13° 00'	441'	.068	120	180	.080	170	250																		
14° 00'	409'	.070	130	190	D max = 12.5°																				
16° 00'	358'	.074	130	200																					
18° 00'	318'	.077	140	210																					
20° 00'	286'	.079	140	210																					
22° 00'	260'	.080	140	220																					
		.080	140	220																					
		D max = 23.0°																							

$e_{max} = 0.08$

D -- Degree of curve
R -- Radius of curve
V -- Assumed design speed
e -- Rate of superelevation
L -- Minimum length of runoff of spiral curve
NC -- Normal crown section.
RC -- Remove adverse crown, superelevate at normal crown slope.
Spirals desirable but not as essential above heavy line.
Lengths rounded in multiples of 25 or 50 feet permit simpler calculations.

TABLE IV

VALUES FOR DESIGN ELEMENTS

RELATED TO DESIGN SPEED AND HORIZONTAL CURVATURE

D	R	V = 30 mph			V = 40			V = 50			V = 60			V = 65			V = 70			V = 75			V = 80 mph		
		e	L-Feet		e	L		e	L		e	L		e	L		e	L		e	L		e	L-Feet	
			2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane
0° 15'	22918'	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	240	240
0° 30'	11459'	NC	0	0	NC	0	0	NC	0	0	RC	175	175	RC	190	190	RC	200	200	.022	220	220	.024	240	240
0° 45'	7639'	NC	0	0	NC	0	0	RC	150	150	.024	175	175	.027	190	190	.029	200	200	.033	220	220	.036	240	240
1° 00'	5730'	NC	0	0	RC	125	125	.023	150	150	.032	175	175	.035	190	190	.039	200	200	.044	220	220	.048	240	240
1° 30'	3820'	RC	100	100	.021	125	125	.033	150	150	.046	175	190	.052	190	220	.058	200	260	.065	220	310	.071	240	350
2° 00'	2865'	RC	100	100	.028	125	125	.042	150	150	.058	175	230	.066	190	290	.074	220	330	.082	260	390	.089	290	440
2° 30'	2292'	.021	100	100	.034	125	125	.051	150	180	.069	190	280	.077	220	330	.086	260	390	.094	300	450	.099	330	490
3° 00'	1910'	.025	100	100	.040	125	125	.059	150	210	.079	210	320	.087	250	380	.094	280	420	.100	320	480	.100	330	500
3° 30'	1637'	.029	100	100	.046	125	140	.067	160	240	.087	230	350	.093	270	400	.099	300	450	.100	320	480	.100	330	500
4° 00'	1432'	.033	100	100	.051	125	160	.073	180	260	.093	250	380	.098	280	420	.100	300	450	D max = 3.0°			D max = 3.0°		
5° 00'	1146'	.040	100	110	.061	130	190	.084	200	300	.099	270	400	.100	290	430	.100	300	450						
6° 00'	955'	.046	100	120	.070	150	220	.092	220	330	.100	270	410	D max = 4.5°			D max = 4.0°								
7° 00'	819'	.053	100	140	.077	160	240	.098	240	350	D max = 5.5°														
8° 00'	716'	.059	110	160	.084	180	260	.100	240	360															
9° 00'	637'	.064	120	170	.089	190	280	.100	240	360															
10° 00'	573'	.068	120	180	.093	200	290	D max = 8.5°																	
11° 00'	521'	.073	130	200	.097	200	310																		
12° 00'	477'	.077	140	210	.099	210	310																		
13° 00'	441'	.080	140	220	.100	210	320																		
14° 00'	409'	.083	150	220	.100	210	320																		
16° 00'	358'	.089	160	240	D max = 13.5°																				
18° 00'	318'	.093	170	250																					
20° 00'	286'	.097	170	260																					
22° 00'	260'	.099	180	270																					
24° 00'	239'	.100	180	270																					
		.100	180	270																					
		D max = 25.0°																							

$e_{max} = 0.10$

D -- Degree of curve
R -- Radius of curve
V -- Assumed design speed
e -- Rate of superelevation
L -- Minimum length of runoff of spiral curve
NC -- Normal crown section.
RC -- Remove adverse crown, superelevate at normal crown slope.
Spirals desirable but not as essential above heavy line.
Lengths rounded in multiples of 25 or 50 feet permit simpler calculations.

TABLE V

VALUES FOR DESIGN ELEMENTS

RELATED TO DESIGN SPEED AND HORIZONTAL CURVATURE

D	R	V = 30 mph			V = 40			V = 50			V = 60			V = 65			V = 70			V = 75			V = 80 mph		
		e	L-Feet		e	L		e	L		e	L		e	L		e	L		e	L		e	L-Feet	
			2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane
0° 15'	22918'	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	240	240
0° 30'	11459'	NC	0	0	NC	0	0	NC	0	0	RC	175	175	RC	190	190	RC	200	200	.022	220	220	.024	240	240
0° 45'	7639'	NC	0	0	NC	0	0	RC	150	150	.024	175	175	.026	190	190	.029	200	200	.033	220	220	.036	240	240
1° 00'	5730'	NC	0	0	RC	125	125	.023	150	150	.031	175	175	.035	190	190	.039	200	200	.043	220	220	.048	240	240
1° 30'	3820'	RC	100	100	.022	125	125	.034	150	150	.047	175	190	.053	190	230	.059	200	270	.065	220	310	.072	240	360
2° 00'	2865'	RC	100	100	.030	125	125	.045	150	160	.062	175	250	.070	200	300	.078	230	350	.087	280	410	.095	310	470
2° 30'	2292'	.022	100	100	.037	125	125	.055	150	200	.076	210	310	.085	240	370	.095	290	430	.105	330	500	.113	370	560
3° 00'	1910'	.026	100	100	.044	125	140	.065	160	230	.088	240	360	.097	240	420	.108	320	490	.117	370	560	.120	400	600
3° 30'	1637'	.030	100	100	.050	125	160	.074	180	270	.098	260	400	.107	310	460	.116	350	520	.120	380	570	.120	400	600
4° 00'	1432'	.034	100	100	.057	125	180	.082	200	300	.106	290	430	.114	330	490	.120	360	540	.120	380	570	D max = 3.0°		
5° 00'	1146'	.042	100	110	.068	140	210	.096	230	350	.117	320	470	.120	350	520	.120	360	540	D max = 3.5°					
6° 00'	955'	.049	100	130	.079	170	250	.107	260	390	.120	320	490	.120	350	520	D max = 4.0°								
7° 00'	819'	.055	100	150	.088	180	280	.114	270	410	.120	320	490	D max = 5.0°											
8° 00'	716'	.062	110	170	.096	200	300	.119	290	430	D max = 6.0°														
9° 00'	637'	.068	120	180	.103	220	320	.120	290	430															
10° 00'	573'	.074	130	200	.108	230	340	.120	290	430															
11° 00'	521'	.079	140	210	.113	240	360	D max = 9.0°																	
12° 00'	477'	.084	150	230	.116	240	370																		
13° 00'	441'	.089	160	240	.119	250	370																		
14° 00'	409'	.093	170	250	.120	250	380																		
16° 00'	358'	.101	180	270	.120	250	380																		
18° 00'	318'	.108	190	290	D max = 14.5°																				
20° 00'	286'	.113	200	310																					
22° 00'	260'	.117	210	320																					
26° 00'	220'	.120	220	320																					
		.120	220	320																					
		D max = 26.5°																							

$e_{max} = 0.12$

D -- Degree of curve
R -- Radius of curve
V -- Assumed design speed
e -- Rate of superelevation
L -- Minimum length of runoff of spiral curve
NC -- Normal crown section.
RC -- Remove adverse crown, superelevate at normal crown slope.
Spirals desirable but not as essential above heavy line.
Lengths rounded in multiples of 25 or 50 feet permit simpler calculations.

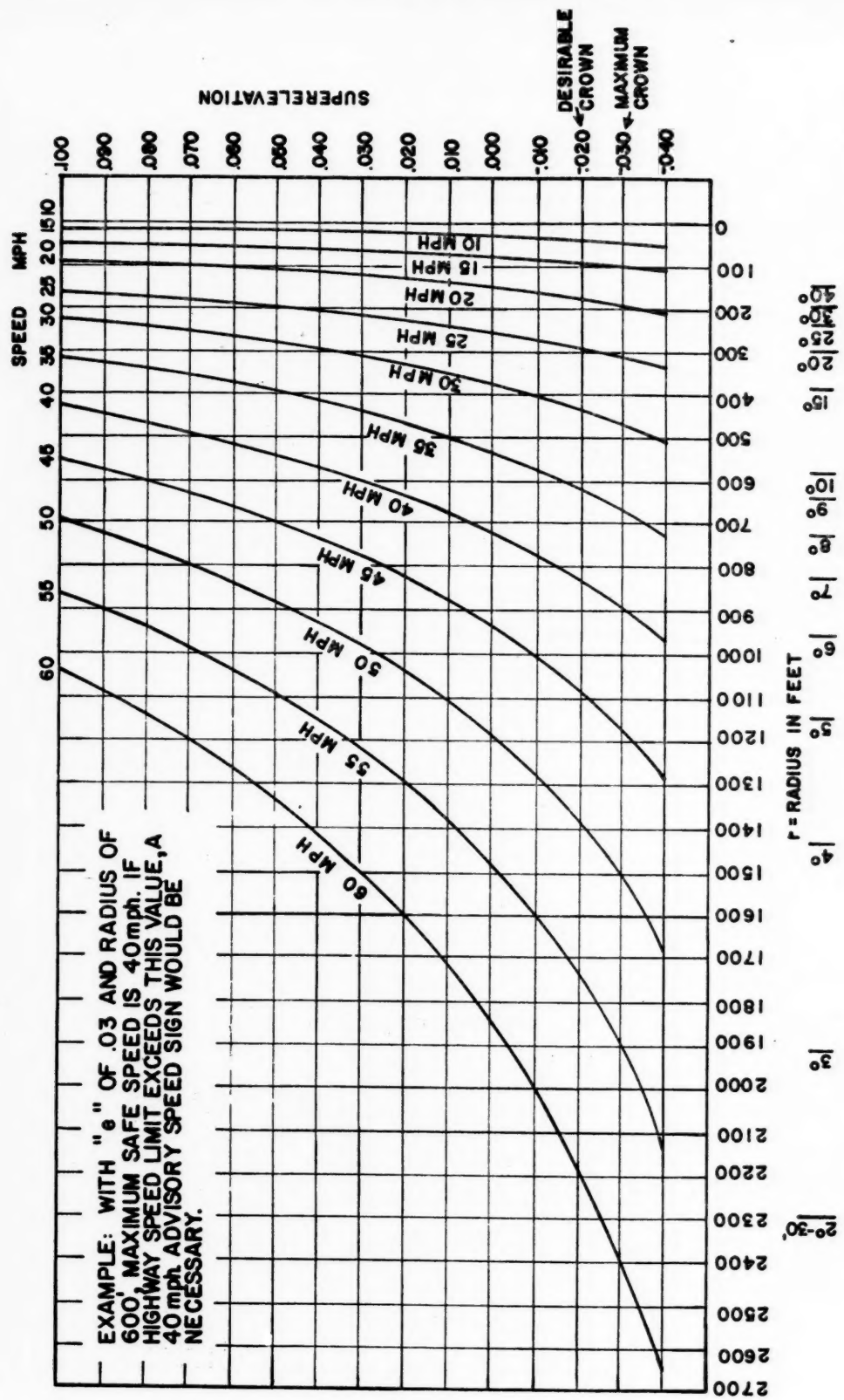

Figure I. Superelevation Chart for Determining Safe Speed for Signing Curves.

APPENDIX B—AVAILABILITY OF REFERENCES

The referenced AASHTO (formerly AASHO) documents are available from: American Association of State Highway and Transportation Officials, 444 North Capitol Street NW., Suite 225, Washington, D.C. 20001.

The National Cooperative Highway Research Program (NCHRP) Research Results Digests may be obtained from: Transportation Research Board, National Research Council, 2101 Constitution Avenue NW., Washington, D.C. 20418.

The following are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402:

Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways, FHWA 1971, Stock Number 5001-0021*

The Status of the Nation's Highways: Conditions and Performance, Report of the Secretary of Transportation to the United States Congress, September 1977.

This notice of Proposed Rulemaking is issued under the authority of 23 U.S.C. 109 and 315 and 49 CFR 1.48(b).

Issued on: August 15, 1978.

KARL S. BOWERS,
Acting Federal
Highway Administrator.

[FR Doc. 78-23353 Filed 8-22-78; 8:45 am]

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*Addenda, Official Rulings, and Errata are available from Federal Highway Administration, Office of Traffic Operations, 400 Seventh Street SW., Washington, D.C. 20590.